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Introducing GIS across levels: designing for diversity

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The paper proposes a strategy for designing introductory GIS modules at Birkbeck, University of London. Seven design aspects or elements (content, practical exercises, assessment, pace, mode, level of support, and level of difficulty) for tailoring modules at appropriate levels and for diversity are introduced and their application in Birkbeck's context discussed. Student's perceptions on those elements, obtained from surveying a subset of students who had taken multiple introductory GIS modules, is then presented. The paper concludes with a discussion on the relevance of the proposed design elements, reflecting on the differences between tutor's design intentions and students' perceptions.

Keywords: diversity, credit levels, teaching design, introduction, GIS

Introduction

This paper builds on the experience of teaching introductory Geographic Information Science (GIS) modules at different credit levels (undergraduate levels 4 and 6, and MSc level 7) to students with diverse backgrounds and studying a range of subject areas and qualifications at Birkbeck, University of London.

Birkbeck is a higher education institution in the UK which specialises in part-time, evening-taught, education for mature students. The College has a long tradition

teaching GIS, having developed the first MSc distance learning GIS programme in the UK which started running in 1998. Ever since, a number of different programmes and GIS modules have been part of Birkbeck's offering at both undergraduate and MSc levels.

Offering introductory courses on GIS across levels presents two main challenges. First, content is essentially the same across levels; and, second, although an introductory module on GIS at any level will always include students who are GIS beginners, a class is rarely totally composed of complete beginners as the body of students tends to have very diverse backgrounds and experiences. These challenges seem to increase in the context of the profile of Birkbeck's student body which traditionally has been composed of part-time and mature students, but recently started to include traditional full-time students. An additional challenge is the progression path of individual students taking multiple programmes, who ultimately might study two introductory GIS modules.

The approach adopted here draws on the theory of constructive alignment, which is based on the idea that "the learner constructs his or her own learning through relevant learning activities" while "the teacher's job is to create a learning environment that supports the learning activities appropriate to achieving the desired learning outcomes" (J. Biggs, 2003, p. 1). This is achieved by aligning elements such curriculum and its intended outcomes, the teaching methods used, and the assessment tasks. The study also concurs with Laurillard's (2012) view of teaching as a design science, which suggests teaching should be understood as a design process which is progressively refined in multiple iterations. For Laurillard (2012), initial module designs are iteratively improved based on the observation and reflection on the success (or failure) of techniques over time.

The objective of this paper is to document and share the practices used for designing multiple introductory GIS modules within the challenges presented above. More specifically, the paper proposes a strategy of using design elements beyond content to tailor introductory GIS modules to different levels as well as cater for a diverse student body. This contributes to the existing tradition of collaboration within the geographic information science and technology (GIS&T) "community of practice" (Foote, Unwin, Tate, & DiBiasi, 2012, p. 3).

In what follows, the context in which Birkbeck's introductory GIS modules have been designed in reference to credit levels and students' diversity will be presented. This is followed by a discussion on the importance and challenges of introductory GIS modules. The approach to introductory GIS modules design adopted by Birkbeck is then presented, detailing each of the seven design elements (content, practical exercises, assessment, pace, mode, level of support, and level of difficulty) proposed for tailoring modules at appropriate levels and for diversity. Student's perceptions on those elements, obtained from surveying a subset of students who had taken multiple introductory GIS modules, is then presented. The paper concludes with a discussion on the relevance of the proposed design elements, reflecting on the differences between tutor's design intentions and students' perceptions.

Context: Credit Levels and Students' Diversity

> "Credit level descriptors define the level of complexity, relative demand and autonomy expected of a learner on completion of a module or programme of learning. They provide a description of levels of learning through a hierarchy of knowledge and skills." (SEEC, 2010, p. 5)

Credit levels have been widely implemented as part of the Credit Accumulation and Transfer (CAT) Framework (for a discussion, see Winter, 1993, 1994) and are an important element of the credit system established in education across the UK. The main uses of levels descriptors include: "(a) to guide the assignment of credit through the writing of learning outcomes, (b) in curriculum design, (c) to assist in writing assessment criteria and the setting of standards, (d) to support the recognition of prior learning, (e) to aid the communication to learners of expectations, and (f) for the purposes of staff development" (SEEC, 2010, p. 5). Thus, credit levels are also an important element in curriculum design and are used to guide the writing of learning outcomes, ensuring the outcome statement of a module is clearly appropriate to its level (Moon, 2004). This is in line with Bigg's (2003) view that the desired outcomes of teaching are not only defined in terms of topic content, but also in the desired level of understanding to be achieved by students.

In pedagogic terms, the importance of credit levels lies in their ability to portray progression. According to Moon (2005), level descriptors have been developed based on observations of pedagogical activity by education researchers. Level descriptors suggest an increasing expectation of student's learning abilities and, as such, increased challenges for students as levels increase.

The design of credit levels in UK higher education was based on yearly progression by students and is part of a broader progression structure which also encompasses lower qualifications. Thus, starting on level 4 for first year of undergraduate programmes, levels progress to level 5 (Year 2), level 6 (Year 3), then level 7 for MSc programmes, and finally level 8 for PhD (SEEC, 2003).

Moon (2005) suggests "level descriptors are made up of 'strands' of areas of development that follow through all levels. While these can be identified as separate,

most are not independent – they interrelate" (p.113). She classifies the strands into those related to the *context of learning* and those related to the *learner's qualities and abilities*. Amongst the strands related to the context of learning are: change in complexity of knowledge presented, change in complexity of tasks the learner is expected to tackle, and change in the support for, or guidance given to learners (student autonomy) (Moon, 2005).

While Moon's strands related to the context of learning can be incorporated into module design, the learner's qualities and abilities are inherent to the learner. Those include the capacity of being autonomous; ability to study, research and manage resources and information; self-management and ability to evaluate own performance; skills of manipulation of knowledge (analysis, synthesis, evaluation and application); capacity to deploy knowledge in solving problems; and understanding of the nature of knowledge and knowing (Moon, 2005). Thus, the module designer has control over the strands related to context of learning, but little control over the strands related to learner's qualities and abilities, which assume a higher level of autonomy and decreased need of support as levels progress.

Thus, while it is accepted the same content can be covered at different levels, the context in which it is delivered and the expectations on the student's abilities to manipulate and use such knowledge with increased autonomy changes as levels progress. This model, however, relies to some extent on an assumption that all students within a group have equivalent abilities. A similar assumption is made when designing learning outcomes, which are defined based on "the minimum acceptable standard to enable a student to pass the module" (Kennedy, 2006, p. 41).

Since leaners' abilities depend on a number of individual characteristics as well as the students' prior experience, both life (personal, work) and academic experience, in practice a class of students is seldom homogeneous.

When designing a course at a certain credit level, the designer usually makes assumptions about the level of abilities the student body has and, therefore, about the minimum standards they can achieve as a group. When teaching at level 4, it is usually assumed the student body will be composed of beginners in higher education while for a module at level 7 (MSc), it is assumed all students have successfully completed an undergraduate degree and, as such, have developed certain skills along that experience.

The reality is groups of learners are often very diverse, as described by Meitner, Gonzales, Gandy, and Maedel (2005): "They start in different places, are composed of varying distributions of individuals and progress at different rates" (p.5). Although such assumptions are to some degree, necessary, they are also unrealistic as diversity is not taken into account. At Birkbeck, where evening-taught and part-time studies attract a number of students changing careers, students who hold an undergraduate or even an MSc award in a different discipline can be found taking an undergraduate level 4 GIS module. Similarly, individuals with sound work experience in a field of studies such as GIS are eligible for programmes even without previous experience in higher education. Consequently, the body of students have mixed skills, abilities, experiences and academic maturity. In GIS in particular, students with substantive working experience in the industry apply to the MSc Programme with the objective of gaining a broader understanding of the subject, as well as official recognition through an academic award, to validate their existing knowledge and experience in order to progress in their careers. Such students find themselves studying side by side with complete GIS beginners, who are eligible to the programme based on their academic experiences.

Thus, when designing a module for a student group with very diverse abilities, it is important to recognise that the level of understanding students are able to achieve might range considerably. In such cases, the teacher's job is not only to create a learning environment with activities which will allow students to achieve the desired (but minimum) requirements, but to design learning activities which will maximise students' opportunities to fully engage with the content and consequently achieve their potential individual outcomes.

Introducing GIS

Introductory GIS modules are often the entry point into GIS programmes, but can also be included in the curriculum of other degrees such as Environment, Geography, Archaeology, Geology, and Computer Science at both undergraduate and masters' levels.

As the first module students take on a GIS programme, the introductory module plays the important role of attempting to bring students coming from different backgrounds and with different abilities to the same level, from which all students will have the necessary foundation to progress in learning GIS. When introductory GIS courses are part of a curriculum in a related area, an optional module will need to attract enthusiasts, while compulsory or core modules will need to be careful not to discourage students from the field.

Content-wise, introductory GIS modules are the simplest to design. The GIS curriculum is well established (DiBiase et al., 2007; K. K. Kemp & Goodchild, 1992), and there seems to be consensus in the field on which core topics should be covered at introductory level. Due to the practical nature of GIS, it has been traditionally taught using problem-based and active learning approaches (Foote et al., 2012; Meitner et al., 2005; Schultz, 2012) although it is also recognised that teaching methods should aim for

a combination of declarative and functioning knowledge, as defined by Biggs and Tang (2007, p. 89). An integrated programme of lectures and practical sessions is normally employed for teaching GIS (see Meitner, Gonzales, Gandy, & Maedel, 2005; Scheyvens, Griffin, Jocoy, Liu, & Bradford, 2008; Schultz, 2012).

Thus, the relevant design challenges are imposed by the context of levels and students' diversity discussed above. An additional challenge is to design introductory GIS modules which may be part of a single student's progression path across levels. For instance, a student who takes an optional introductory GIS module at undergraduate level and might then progress to an MSc where a compulsory introductory GIS module is required. Although these issues are not unique to Birkbeck, this particular case has happened on a number of occasions in its context.

The design of Birkbeck's introductory GIS modules

At undergraduate level, Birkbeck has offered two different introductory GIS modules within the last decade: one level 6 option module which is offered across a number of different undergraduate programmes; and a level 4 compulsory module designed for a Certificate in Higher Education in GISc Programme.

The MSc GISc Programme has changed its mode of delivery as well as curriculum throughout the years, starting out as a pure Distance Learning programme, then having two parallel modes of delivery (distance and blended learning) from 2007 and finally turning into a face-to-face programme in 2011. Different versions of introductory GIS modules were designed throughout this process, all at level 7, varying mostly in mode (distance learning, blended learning, and face-to-face) but also in number of credits (15 or 30).

In designing introductory GIS modules, a number of aspects (or design elements) have been identified and used to both tailor a module at a particular level and

cater for a diverse student body. Below is a brief discussion of those elements which, while having some degree of overlap, are useful in identifying the appropriate delivery approach in the context provided above.

Content

The curriculum of an introductory GIS course is usually very standard, independently of the level the course is taught at. Teaching content has been widely discussed by the GIS teaching and research community which relies on the NCGIA Core Curriculum in GIS (K. K. Kemp & Goodchild, 1992) and Geographic Information Science and Technology Body of Knowledge (DiBiase et al., 2006) documents for guidance. Despite variation in the order of progression of certain topics as pointed out by Foote (2012), for introductory courses this process is straightforward. Not only because introductory GIS topics were clearly stated in the 1990 version of the NCGIA Core Curriculum in GIS (for list see K. Kemp, 2012, p. 50), but also because of the collaborative nature of the teaching community within the GIS&T field (Foote et al, 2012).

Yet, it is possible to teach those topics with different degrees of depth, using a spiral design as proposed by Foote (2012) and Painho & Curvelo (2012), depending on the level of the course and the experience of the study body. There can also be great variation in how the nature of knowledge is presented to students, from established concepts and methodologies to a context in which the provisional nature of knowledge is evident, as suggested by Moon (2005).

It has been argued that 'the greatest enemy of understanding is coverage' (Gardner, 1993, p. 24) so tutors must be aware of the trade-off between breadth of coverage and depth of understanding achieved by students. According to Biggs and Tang (2007), one can either cover a lot of content or promote deep learning – both together are not possible. Taking this concept across levels, if coverage remains

constant in all introductory modules and level of complexity is supposed to increase, then deeper understanding should be achieved as levels increase.

Practical exercises

As highlighted by West (2012), learning GIS requires balance between theory and practice. Practical exercises are an essential part of any GIS course and promote active learning, where the learning experience is centred on the student through the use of activities (Schultz, 2012). This approach has been widely adopted within the field (Foote et al., 2012) as it has great affinity with the practical nature of GIS teaching, where students are effectively being trained to solve real-world problems using spatial analysis techniques. However, active learning requires more than simply doing an activity, it requires thinking and reflecting on the experience (Gibbs, 1988; Scheyvens et al., 2008).

Practical exercises are usually tailored to a specific GIS software package and are often provided by the software company as accompanying training material. For open source software, practical exercises are often made available by the academic community through Open Educational Resources. As designing and preparing tailored exercises can be very time consuming, in particular due to the constant release of new software versions and the consequent need for updating, ready-made exercises are often used to support GIS teaching. Such exercises, however, are often designed in the form of detailed step-by-step instructions which can be so detailed students can complete exercises without having to fully engage with the materials and, consequently, only achieve superficial learning.

At Birkbeck, the lack of deep engagement with ready-made materials is more noticeable at undergraduate than at Masters level. This is likely due to MSc students having a clearer professional motivation in learning the subject, while undergraduates

take the module as optional courses within a larger portfolio. Another relevant factor is MSc students tend to be more independent learners and likely to further explore and go beyond the provided exercises by themselves. An additional challenge in using ready-made materials is a single set of introductory exercises are usually available, and those are not usually aligned to any specific credit level.

The solution adopted was to complement the ready-made exercise materials with tailored exercises, promoting full engagement with materials and encouraging deeper understanding. Such exercises should be problem-based and exploratory, encouraging the student to question assumptions and revisit concepts, thus reflecting on the practice experienced. Using a combination of ready-made and tailored exercises is also an effective way to keep a diverse group of students motivated while allowing each to learn at their own pace. In very diverse groups, a single set of practical exercises can result in some students quickly losing motivation, because the practical exercises are either too hard or too easy, and therefore either take too long or are completed too quickly. Offering a set of extra practical exercises that are released on an individual basis provides the faster students with a challenging individual progression path while not undermining the progress of the overall group.

The solution of combining both types of practical exercises was seen as a necessary compromise, reducing the time taken to update exercises while offering students a variety of detailed and exploratory materials. This solution was used in all introductory GIS modules across levels. Although the same set of ready-made exercises was used to build a knowledge base in all modules, the complementary exercises allowed for tailoring students learning to the appropriate level by changing the challenge level of exercises while covering similar content, thus aiming for deeper

understanding at higher levels. The amount of support provided for practical exercises was also tailored to the level, with greater support in lower level modules.

Assessment

There seems to be an emerging consensus that assessment is not only at the heart of the learning process, but also at the core of the many challenges facing higher education (Ball et al., 2012). Assessment has been traditionally classified into two types: formative and summative. The first is usually not formally marked but designed *for* learning with emphasis on learning from feedback. The latter is designed to test acquired knowledge and judge performance so the emphasis is on the achievement by the student translated by a grade or mark. While balance between summative and formative assessments is considered good practice, there is evidence that in practice the majority of assignments in higher education are summative (Ball et al., 2012). As a consequence of such imbalance, there is a call for transforming assessment in higher education (Ball et al., 2012) shifting the focus from assessment *of* learning (summative) to assessment *for* learning (formative).

It has been accepted that assessment largely defines student's learning priorities (Brown, Bull, & Pendlebury, 1997). Often, it is when working on the assessment students actually learn GIS. This is in line with active learning as well as problem-based learning concepts which are both relevant for GIS. Thus, the approach adopted here concurs with Hyland's (2014) view that assessment *is* learning.

In a context of part-time, mature students, students often are strategic regarding time management and, as a consequence, purely formative assessments (those not formally marked) tend to be low on the student's priorities and only submitted by a minority. As a result, a compromise between formative and summative was reached

where learning and feedback was embedded into the assessment process in the form of guidance and support to students while carrying out coursework activities.

Based on those principles, a flexible practical coursework project, which also addresses the aforementioned challenges of a diverse student body, was designed and implemented for all introductory GIS modules. This design contains three elements:

(1) An assessed practical activity which does not replicate activities or exercises done in class, but which required synthesising and problem-solving skills based on what had been learnt within the module.
(2) Marking criteria with clearly specified minimum requirements which encouraged students to go beyond minimum requirements by explicitly rewarding exploratory analysis and allowing multiple analysis paths rather than single methods or answers.
(3) Support and guidance to students which allows less able students to achieve minimum requirements while encouraging high end students to further exploratory of analysis as well as use of data beyond minimum requirements.

This flexible approach to assessment design allows the use of a single assessment which is challenging to a diverse group, enabling a) less able students to feel supported and achieve the minimum requirements, b) students with time (or motivation) constraints the choice of the level of achievement they wish to aim for (the more complexity the work demonstrates, the higher is the mark), and finally c) ‘high-end’ students to challenge themselves via assessment and achieve high marks. This is in line with providing students with individual progression paths within the module without compromising the learning and motivation of the overall group.

This assessment design was applied to all introductory GIS modules with the exception of the level 4 module, where a less complex assessment design was deemed

appropriate. On the introductory module at level 6 (undergraduate), the module is divided into two parts. The first half of the module is focused on developing students' knowledge base in GIS by using a mixture of lectures and self-paced exercises. The second part of the module is dedicated to the practical project and a problem-based teaching approach is adopted, where students are encourage to find solutions for the problem presented with the support from teaching staff. Students' results using this assessment design over 10 years have proved the design successful and overall student feedback on assessment has been positive.

Pace

Pace is one of the key elements of a flexible learning framework, as identified by the Higher Education Academy (HEA) (Hammersley, Tallantyre, & Le Cornu, 2013), together with place and mode. The HEA flexible learning framework focuses on the choices made by the student regarding their learning, where pace "refers to accelerated and decelerated programmes including part-time learning and the recognition of prior learning. It can also include a variable pace of study within a programme's overall deadlines." (Hammersley et al., 2013, p. 4).

While pace is normally discussed across a programme of study, its concept was reinterpreted here as pace *within* a module and proposed as a design element, which can also be used by the tutor to tailor a module across credit levels. In this interpretation of the concept, two aspects of pace are relevant: the first aspect can be imposed by the tutor, setting the speed of content delivery, as well as the expectations of students regarding the timing of activities, exercises and assessments. For example, when content breadth is fixed, a faster pace can increase the challenge level of a module as it effectively determines an expectation on speed of student learning. It can also impact on

the rate of tutor contact or class time per learning activity. Thus, a faster pace tends to both assume and require a more independent learner. At Birkbeck, higher level introductory GIS modules were designed to be delivered at a faster pace. Some of the MSc face-to-face modules have a significantly reduced number of sessions (as well as credit value) in comparison to its undergraduate counterparts, while covering equivalent content.

The second aspect of pace relevant here is related to the HEA's focus on flexibility of choice by the students. In a diverse group, students will learn at different speeds, so some flexibility in pace within the module is important in order to cater for diversity. A degree of such flexibility in pace has been included to GIS introductory modules with the use of self-paced exercises as discussed above.

Mode

Mode indicates how the module (or programme) is delivered: face-to-face, distance learning, or blended learning. However, with the use of Virtual Learning Environments (VLEs) and online exercises, often face-to-face modules have embedded elements of online learning. These offer the student added flexibility, but also mean the student is expected to work on their own, rather than in class, where both peer and tutor support are not as easily available.

There are also implicit assumptions on student's independence that are embedded in mode as often distance learning students are assumed (as well as required) to be more independent than their face-to-face counterparts. It is known distance learning education is better suited for independent and IT literate learners (McMaster & McMaster, 2012) and, thus, it could be argued there is a self-selection process in who applies for distance learning programmes versus those who apply for traditional face-to-face programmes.

Although the mode of a module is usually not fully controlled by the module tutor, as it is normally decided at programme level, it is possible to design learning activities that are carried out in different modes *within* a module. While those can be seen as 'homework' which has always been used in teaching, the delivery of such materials via VLEs has allowed for a wider variety of activities to be introduced. Those include online tests, self-paced exercises, and even videos or podcasts which can serve as either reinforcement or replacement (in the case of flipped-classroom) to face-to-face lectures. When introducing online activities, however, it is important to consider the effect a change in mode in any significant portion of module activities may have on the overall expectation on students' autonomy, and whether those are in line with both module credit level and student body capabilities.

Level of support

The level of support to be provided in each module is guided by the level of independence expected from the student and indicated by credit level descriptors. However, this is also an issue regarding student prior experience, in particular regarding digital literacy (Meitner et al., 2005). Beginners to GIS, and those who are less computer literate, can easily feel overwhelmed by the novelty of concepts, together with technical challenges, without the necessary support. Level of support also needs to be aligned with practical exercises and assessment design. More challenging, exploratory practical exercises require more support to assure less confident and able students can maintain the learning pace. Similarly, exploratory assessment design often requires additional support as previously discussed.

The overall rule applied for the introductory GIS modules at Birkbeck was to provide decreasing support as credit levels increased, while assuring support was also tailored to the design of learning activities.

Level of difficulty

Progression can be thought of in terms of increased difficulty which is directly related to content, both depth and breadth. When working with fixed content breadth in modules in different levels, variations in difficulty can only occur by increasing the depth of understanding to be achieved by students. Perhaps a more appropriate term is 'level of complexity' as proposed by Moon (2005) in regard to the context within which content is presented. Moon (2005) refers to complexity of knowledge with regards to both the degree of challenge learning materials present to students and the change in complexity of tasks students are expected to tackle. Another related aspect is what Moon refers to as "the learner's understanding of the nature of knowledge and knowing", which can evolve from an understanding of facts as 'truths' to a realization of how knowledge is built and its provisional nature (Moon, 2005, p. 116). This means that, while covering the same content, it is possible to present it in a more complex context.

The level of difficulty of an introductory GIS module is, however, not only of a matter of content. First, it relates to student's perceptions of content based on their own abilities and prior experiences, not only with education but also with GIS and digital technology in general. Second, such perception can be related to changes in other aspects such as pace, mode and level of support, which can impose increased expectation on students' autonomy as credit levels get higher.

Not all design elements discussed above are equally relevant for all introductory GIS modules. Isolating each of those module design aspects and thinking of them as design elements can help the tutor to understand the choices available to him/her to tailor modules to the appropriate level and to a particular student body.

Content coverage, practical exercises and assessments tend to be thought of as content-related activities which can be tailored to level by increasing the level of complexity and demand on students. When examining these elements in the light of pace, mode and levels of support, new nuances are revealed, allowing the tutor to reuse learning activities such as lectures or exercises across levels while tailoring the overall student experience at the appropriate level. Pace and mode can also have an impact on the students' perception of difficulty as, for instance, a faster pace or change to a mode with less face-to-face contact can impose increased challenge to students. Thus, perception of difficulty seems to be related to the level of expectation set on the student, which can be designed by a combination of levels of complexity in learning activities as well as changes to context settings.

Thus, it is possible to classify the above design elements into two groups: 'content-related' (content, assessment, and practical exercises) and 'settings' (pace, mode, and level of support). Level of difficulty is perhaps better described as level of complexity and seems to be the result of interplay between all other design elements. Two interesting aspects arise from level of difficulty: the actual level of challenge imposed on the student body and the perception students have of such challenge. While these are usually thought in regards to content-related elements, perceptions (as indeed actual challenge levels) can also be increased by changing settings elements. It is possible to think of the proposed 'settings' as design elements capable to alter module level related to Moon's strand on learner's qualities and abilities giving the tutor greater control over the learning experience offered to students.

Student experience

The seven elements discussed above have been used to design all introductory GIS modules in Birkbeck and their implementation has been improved iteratively over the

years based on learnt experience and student feedback. In order to assess the efficacy of the design implemented, it was necessary to compare design intentions to students' experience across different levels. Thus, a particular group of students who had taken multiple introductory modules at Birkbeck were identified and invited to complete a short questionnaire on their experiences. A total of 13 students were invited to participate, from which 7 have responded to the survey. Although small, this particular subset of students was selected for their unique position in commenting on the effects of the design proposed across credit levels. Even though the sample is not large enough for a statistical analysis, the responses obtained were informative.

Students who have completed the questionnaire had taken a different set of modules. They have taken either the compulsory level 4 module or the level 6 option module and then progressed to the MSc GISc Programme where an introductory GIS module at level 7 was compulsory. The MSc level modules ranged between 15 and 30 credits and modes (distance learning, blended, face-to-face). All questionnaire questions refer to either content or delivery techniques and were not concerned with student or teaching performance.

Students were asked about their experience with GIS prior taking the modules. Two respondents had previous experience with GIS, either on previous studies (elsewhere) or work experience, while the others were complete beginners. Students were asked to comment on overlaps, differences and similarities between introductory GIS modules they had taken on the following aspects: content, pace, mode, level of support, level of difficulty, assessment, teaching materials and practical exercises.

All respondents have identified some degree of overlap in content. When commenting on content, respondents mentioned both modules overlap in their introductions with MSc module becoming "more specialised and in-depth as the course

progressed" or being generally more 'advanced'. One respondent mentioned the MSc had a greater integration between theory and practice, but later added that his perception could be a consequence of his own experience and understanding obtained from the previous module.

Regarding pace, students comments on the MSc modules 'intensity'. One respondent stated: "The amount of teaching time seemed about the same in both but the amount of learning material in the MSc and the amount of self-motivated study was about twice as much." This comment seems to refer to the level of independence expected of the student as much as it refers to the pace of delivery. Another student mentioned the undergraduate module "was a lot slower compared with what you were expected to learn in a shorter period of time on the MSc", while another commented "speed was challenging but manageable".

Comments on the level of difficulty suggest pace and mode were important elements in students perceptions. A respondent who had taken the MSc in blended mode said "the MSc module was definitely harder and intense".

When asked about level of support, a single respondent has identified the level of support on the undergraduate module was greater than the MSc, with other respondents stating satisfaction with the level of support received.

From students' comments on teaching materials and practical exercises, it is clear they have identified similar materials were used, with some students highlighting updates. Responses also demonstrate students realise the increased amount of reading required at an MSc level. Similarly, when commenting on assessments, students have identified the MSc assessments as "more challenging". A respondent cited those were "longer pieces of work" which required "more in-depth analysis and encouraged more collaboration between students".

When asked whether they felt it was beneficial to take two introductory GIS modules, all respondents found it beneficial. They claimed the overlap in content has helped them to “embed the knowledge” and refresh their memories, with one respondent stating the undergraduate introductory module has helped in making his/hers experience on the MSc “less intense”, placing him/her on an advantageous position in relation to colleagues who “had trouble understanding the concepts and applications of GIS”. Two respondents who had taken the level 4 undergraduate module mentioned the course had served as a taster before committing to the MSc, allowing them to make sure the field of studies was suitable for them.

From the responses obtained, student’s perceptions of difficulty are likely to be related to the pace of delivery, as well as expectations of student performance (appropriate to credit levels), both in the form of assessment and degree of independence (self-paced work and readings and level of support provided). This is in line with the idea that design aspects not related to content also contribute to student’s perception of differences in levels of difficulties. Although some of the comments from students seem predictable, it is important to highlight they confirm students’ perception of progression between the modules taken. This is despite a strong overlap in content between modules, which was perceived as an area of concern to lecturers. In fact, an unexpected finding from the survey was students mostly perceived content overlap as beneficial. While it is unclear if such positive perceptions of this overlap are directly related to the variation on other aspects of module design, it can be assumed students perceived differences between the modules as the learning experience as a whole was not seen as repetitive, despite the overlap in content or use of similar practical exercises. This suggests changes in ‘settings’ design elements such as pace, mode, level of support

and difficulty were successfully in creating a differentiated learning experience on two introductory GIS modules at different levels.

Conclusions

The paper proposes a strategy for designing introductory GIS modules covering similar or same breadth of content at different credit levels. It is suggested that by teasing out separate (but interrelated) design elements from the overall module design, the tutor can better understand how to adjust such aspects of a module design in a way to shape student experience which is appropriate to level, while at the same time catering for a diverse student body.

This strategy has been adopted for Birkbeck's introductory GIS modules over a number of years with changes and improvements made iteratively as a result of the tutor's experiences as well as student feedback. When comparing the design intentions to the results of a survey of a group of students who had taken multiple introductory GIS modules at Birkbeck, it was suggested non-content related elements such as pace, mode, level of support also play important roles in shaping students learning experiences. Students' perception, as well as the actual degree of challenge imposed by a module on students, seem to be the result of the interplay between different settings which affect the overall context of learning and not only those directly related to complexity of content or tasks.

Such results demonstrate that despite the tendency for tutors to see content as critical when designing a module, students' experiences suggest other module settings such as pace, mode and level of support can be as useful tools in customising module design. While it is now accepted that student's actual learning outcomes are often more closely related to topics assessed than those delivered, the effects of variations in pace, mode, level of support on students experience are less understood.

As the perception of a student on a learning experience is individual, it is likely that a design which caters for diverse groups and provides a challenging yet supportive learning environment also plays a role in the overall student satisfaction.

In order to provide the same level of challenge across a diverse student group, it is necessary to design learning in a flexible framework, providing individual paths of progression (fast lanes, slower lanes). As suggested by Meitner et al (2005), the solution can be found via balance and flexibility:

> "Balance, in that the course must challenge but not overwhelm the student body as a whole, and flexibility so as to recognize and accommodate a diversity of learners. Most importantly, achieving balance and flexibility requires that the instructor ensure that the course itself does not become entrenched" (p. 5-6)

Such balance can only be achieved by tailoring the learning activities at the appropriate level and to the diversity of a particular student body. While the theoretical basis for such teaching and learning design is important, the refinement of fit of a learning design can only be achieved through reflective practice, by learning from design mistakes and achievements and reviewing practices intermittently as suggested by Laurillard (2012). Sharing reflections on practices as well as practices themselves not only enriches the GIS teaching 'body of knowledge' but is also important to keep the GIS 'community of practice' alive.

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